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ABSTRACT

Research on the coral species composition of St. John's reefs in the Virgin Islands was conducted through the School for Field Studies (SFS) Coral Reef Ecology course (winter 1984). A cooperative study program based on the United Nations Educational, Scientific, and Cultural Organization's (Unesco) program, Man and the Biosphere, was undertaken by faculty and undergraduates of SFS and personnel from the Virgin Islands National Park Service. This report reviews the methods, materials and results of the research project at Great Lameshur Bay on St. John's Island. Base-maps of marine habitats along the reef were constructed from aerial photographs. The maps were used in ground-truthing to determine the species and substrate composition for each area specified in the aerial photographs. Qualitative and quantitative data were obtained from five transects along the reef. Findings on species distribution are summarized in tables and the five dominant species are identified in depth profile graphs. It is indicated that the methodology used is suitable and appropriate for any team of easily trained technicians in other marine environments and that it is also inexpensive and requires a relatively small amount of time for training and implementation of the project. (ML)

ED260912

MAN AND THE BIOSPHERE :
GROUND TRUTHING CORAL REEFS
FOR THE ST. JOHN ISLAND BIOSPHERE RESERVE

Coral Reef Ecology

January 1984

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INTRODUCTION

This research project was conducted through the School for Field Studies Coral Reef Ecology course (winter 1984) with the cooperation of the Virgin Islands National Park Service. The faculty and undergraduate students spent three weeks aboard the 65 foot schooner, Lelanta which was moored in Great Lameshur Bay, St. John, USVI, where they studied coral reefs and underwater research. This report represents the results of their group research project.

The course of study was based on a select collection of coral reef research papers. These were read and critiqued by the group to identify appropriate concepts and techniques for their research. Through consultations with the park's chief scientist, the final research topic was selected based on the Man and the Biosphere objectives. This project attempts to "ground truth" aerial photographs of coral reefs and determine effective methods for future study. The value of the work was considered great at both the local and international level. The group's cooperation and devotion were instrumental in completing a rigorous diving schedule and the preparation of this report.

Great Lameshur Bay 1/15/84

Michael Brody Steve Miller

MAN AND THE BIOSPHERE:

GROUND TRUTHING CORAL REEFS

FOR THE ST. JOHN ISLAND BIOSPHERE RESERVE

Man and the Biosphere (MAB)

In conjunction with man's recent awareness of his impact on the world and its resources, the United Nations Educational, Scientific and Cultural Organization(UNESCO) initiated, in 1971, a program that evaluates man's interaction with the environment (MAB-Workshop, 1983). The program, Man and the Biosphere, was designed with the intent to evaluate "the structure and function of ecosystems and of impacts and repercussions caused by human interactions and to provide the scientific knowledge, trained personnel, and support needed to solve practical problems of natural resource management" (MAB-Prospectus, 1983).

The International Network of Biosphere Reserves, MAB's eighth project, established protected areas(Biosphere Reserves) to be set aside so that long-term research could be conducted and educational opportunities provided(MAB-Prospectus, 1983). The MAB program has formed more than 200 Reserves worldwide that represent the world's biogeographic provinces. The United States Virgin Islands National Park, located on St. John, United States Virgin Islands, currently represents the Lesser Antillean biogeographic province(MAB-Prospectus, 1983), although St. John is in the Greater Antilles. UNESCO and MAB dedicated the park as a Reserve on May 12, 1983(MAB-Dedication, 1983).

The work to be done on St. John includes establishing base-maps of marine habitats in the park from recent aerial photographs. From these base-maps, ground-truthing, through field surveys, will be conducted to determine what each distinct area of the aerial photographs represents in terms of species and substrates(MAB-Prospectus, 1983).

The information collected on coral species composition of St. John's reefs described herein currently represents that of the Lesser Antillean biogeographic province. In a personal communication, Robert Brander, the chief scientist for the Virgin

Islands National Park, stated that, "St. John's coral reefs alone are not a complete representation of the vastly different types of coral reefs found in the Lesser Antilles" (Brander, 1984). He believes that this Biosphere Reserve should be extended to neighboring preserved areas in order to create a multinational Biosphere Reserve that would better represent the area.

School for Field Studeies (SFS) and Virgin Islands Ecological Research Station (VIERS)

The National Park Service currently has funding for the ground-truthing phase of the MAB program on St. John. The present study, the first of this phase, has been conducted by students participating in the Coral Reef Ecology course offered by the School for Field Studies (SFS). SFS first offered courses in the summer of 1981, with 80 students enrolled in 7 courses. Since then, the School has been growing in both enrollment and curriculum at research sites throughout the world. SFS, through its expeditions, is the only national program exclusively devoted to providing students with field training in the natural and environmental sciences. Its goals are to "motivate, inspire and actively educate young people in the complexities of the world's ecosystems and the interrelationships and interdependencies of man with all other species and all aspects of this planet" (Elder, 1983). This educating occurs through direct involvement and actual experience. SFS accepts students of all backgrounds and experience levels, making this study an experiment in itself, to determine if the objectives of the Biosphere Reserve program can be met by relatively inexperienced personnel (Brander, 1984).

The Virgin Islands Ecological Research Station (VIERS) served as the base for this study. VIERS is located in Great Lameshur Bay on St. John, which places it within the boundaries of the Virgin Islands National Park. The continual protection by the Park Service ensures that pristine sites can be found and studied. Research field stations like VIERS make available for reference a staff of resident professional biologists and naturalists. VIERS provides students and scientists with the opportunity to live and work together in natural tropical communities in the Greater

Antilles. Their field research work, as with the MAB project, provides a greater understanding of the functioning of natural systems. This will hopefully lead to "worldwide adoption of preventative measures that will reverse the current trends of pollution and reckless exploitation of the environment" (VIERS, pamphlet).

St. John and the National Park Service

St. John, the location of the study site, along with St. Croix and St. Thomas, comprise the territories of the United States Virgin Islands. With a population of approximately 3,000, this mountainous island lies at eighteen degrees north latitude, seventy-five miles east of Puerto Rico. For all its cultural heritage and rich epifauna, the island itself is only nine miles long and five miles wide. St. John most deserves the designation "Virgin Island," for of its 9,500 acres, 5,650 of them, including surrounding waters, form the Virgin Islands National Park (Robinson, 1974).

The geological history of St. John and all of the Caribbean Islands dates back 100 million years, to the first slow eruption of great volcanic flows onto the ocean floor. As the flows seeped out over millions of years, the great depth of the ocean (approximately 15,000 feet) helped to cool and solidify the magma gradually, to lay the base of the islands. Simultaneously the ocean level lowered, caused by a general uplifting of the area. The next phase of development, violent volcanic activity, left the Louisenhoj formation, a material of explosive volcanic products such as andesite and tuff. This activity continued until the sea floor rose above the water line. The following period was opposite in nature, characterized by volcanic inactivity and accumulation of marine sediments on emerging island slopes. This thin layer of dark silica-bearing limestone today is the Outer Brass. New uplifting later exposed the Louisenhoj and Outer Brass layers, resulting in a layer of weathered debris called the Tutu formation. The last major phenomenon came from severe crustal movement which led to plate folding and defaulting. Further variations came as sea levels rose and fell as a results of glacial activity, and as general build-up and erosion proceeded (Robinson, 1974).

The cultural history of St. John begins with coastal dwelling indians of

South American origin, the Arawaks, who first populated the islands. The Europeans followed, first with the discovery of the northern islands by Columbus in 1493, and then with formal settlement by the Danes in 1759, after many territorial claims and skirmishes between the Danes, th Dutch, the English, and the Spanish. The Danes established elaborate sugar and cotton plantations, which survived until the early 1900's, when competition from mainland grown beet sugar, labor costs, and depleted soil brought them to an end. In 1917, the United States purchased the islands from Denmark. An official appraisal in 1936 by the National Park Service concluded that despite the recreational allure of the pristine beaches and the history behind the sugar plantation ruins, the natural vegetation had been too disrupted by the sugar cultivation to qualify the island as a national park. Interest in creating a park accelerated again in the 1950's with the surge of tourism and commercialism in the Caribbean. Laurance Rockefeller, together with his associates in the Jackson Hole Preserve Corporation, puchased the island and gave it to the United States for the specific purpose of creating a national park. On August 2, 1956, Eiserhower signed legislation to accept the donation and designated a large part of it as a national park (see Figure 1). Later, in 1962, Congress further expanded the park by including a large portion of surrounding water (Robinson, 1974).

Today, the Park Service is confronted with some unique problems, due to the Virgin Islands National Park's unusual status as a land and marine park. It faces the "typical" problems of a land park, such as increasing pressure for development in an area that is quickly gaining attraction for travellers and developers. Also, it experiences severe erosion and sedimentation caused by present development and the total decimation of all original vegetation by the Danes. On the other hand, management of a marine park is more ambiguous and open-ended than for a land park, where boundaries can be marked, territory patrolled, and visitation monitored. Ships and tourists cause daily destruction of the fragile coral reef with anchors, fins, and momento collecting (Brander, 1984). Also, despite man's advances in technology, research under the sea is still more limited than studies on land. The delicate coral

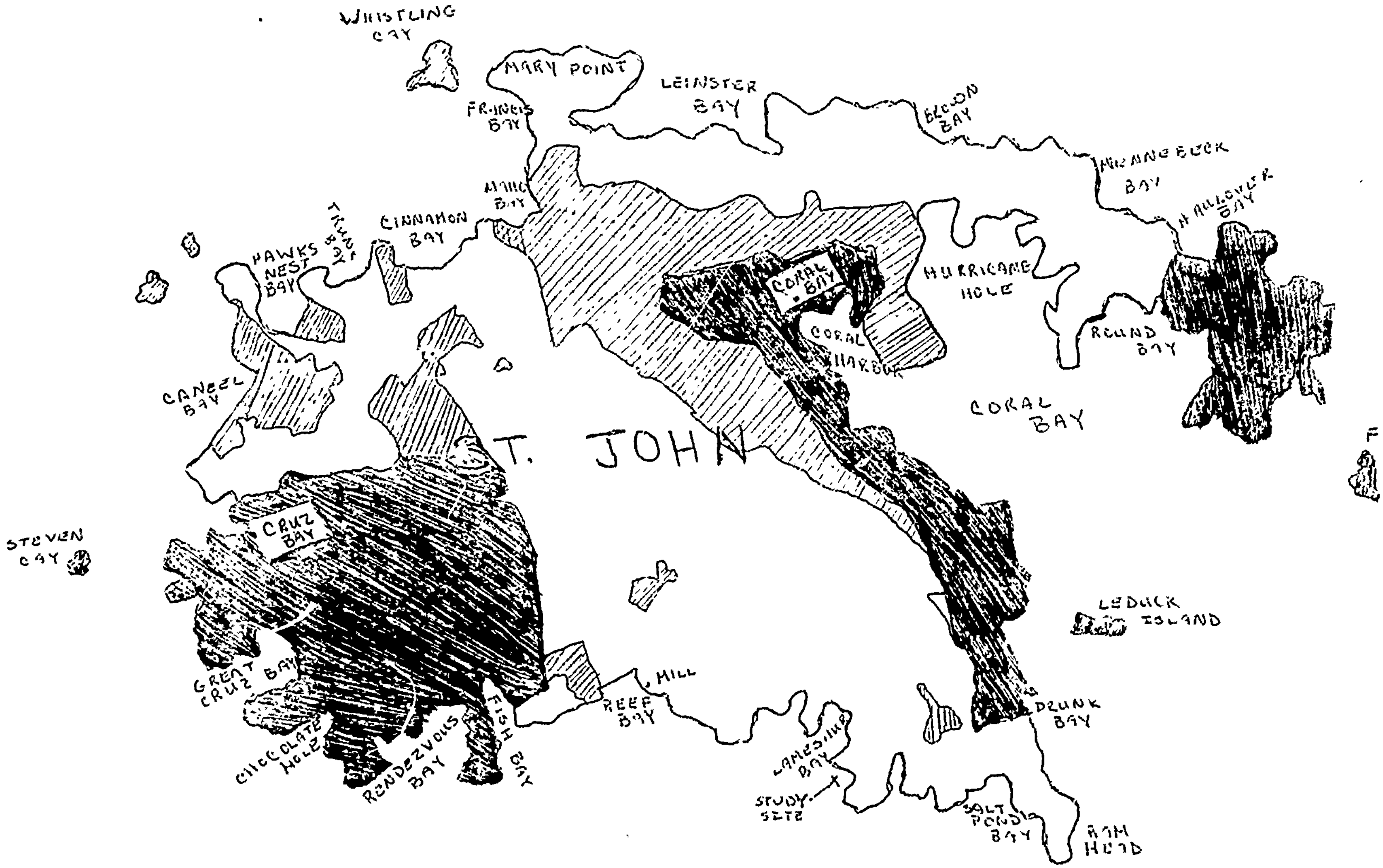

Figure 1. National Park boundaries on St. John Island.

Authorized Park Area

Open To The Public

Privately Owned

Not Federally Owned

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ecosystem plays a very significant and vital role in the balance of the whole island. Not only does the coral reef support the most productive type of ecosystem in the world in terms of biomass and species numbers (Adey, 1983), but the actual coral framework provides glorious sights and pristine white sand beaches. The reef is also the livelihood for one of the largest industries in the area--fishing.

The coral reef community boasts an elaborate and intricate structure. Its base lies in tiny coral polyps, living animals of the phylum Cnidaria, most of the class Anthozoa. They feed on microscopic zooplankton with the use of nematocysts, or stinging cells, on their tentacles, as well as utilizing their symbiotic zooxanthellae as a nutient source. The huge reefs result from the calcium carbonate skeleton which the polyps secrete to protect themselves. The coral is the vital element in the structure, ecology, and nutrient cycling of the reef community.

Because of their national park status, the reefs of St. John are slightly more protected than those left open for exploitation. This isolation and protection were significant factors in the choosing of St. John as the site for the Tektite projects in 1969 and 1971 (Earle and Lavenberg, 1975). The projects, which were experiments in underwater habitation for extensive periods of time, chose Great Lameshur Bay, where the area had had relatively little human tampering and the southern shores were protected from the prevailing northern winds. The coral reefs in Great Lameshur are rich and varied in species and provided an active and varied seascape for studying and observing.

As a result of these previous studies in the area, the National Park Service again has chosen Great Lameshur Bay as the site for the first intensive studies for MAB. Hoping that they might be able to use and compare earlier data, they were also aware of all the physical characteristics which Tektite found so attractive. With the research vessel Lelanta mooored in the bay and with access to VIERS, we found the bay perfect for the project.

Methods and Materials

After receiving a copy of the aerial photographs of St. John from the Park Service (see Figure 2), our first step was to select an appropriate site in Great Lameshur Bay in which to do the ground-truthing and substrate composition research. With the use of a wooden underwater diving sled (Kumpf and Randall, 1961) built at the VIERS facilities, and at an average speed of three knots, we surveyed the bay looking for a site, deciding upon the Tektite reef.

This was due to the previous research conducted in 1971 and the Park Services' subsequent interest in the area.

A common factor to both the qualitative and quantitative parts of our project was the use of SCUBA equipment in the field. Two teams of two divers each went down prior to the beginning of the transect work to complete the site survey, determining a working list of 28 species and of substrates, and also to test and perfect sampling techniques. Once the transect work began, five teams dove twice a day each for five consecutive days. Two teams went down on the reef every two hours while one team stood by to move the transect lines as they were completed. A total of 91.2 man-hours was spent on the transects, ten divers making 100 dives total on the transects. Two small boats transported the divers to the site and back to the base, the VIERS lab and the research vessel, Lelanta.

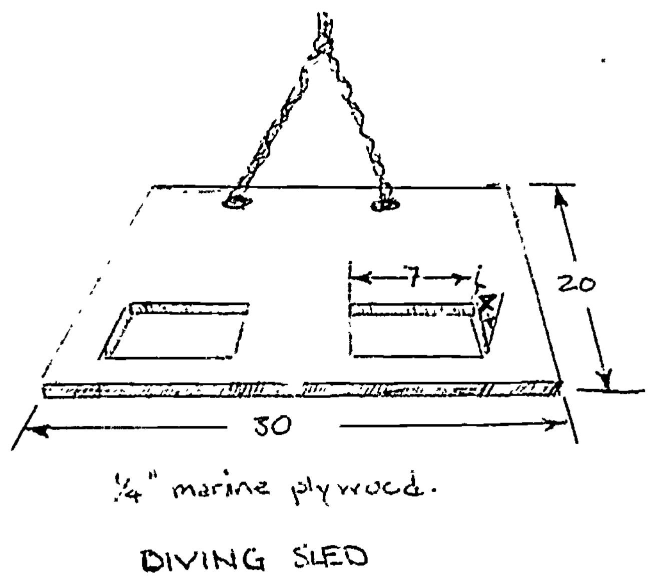

Figure 3. Diving Sled Used in Surveying of Great Lameshur Bay

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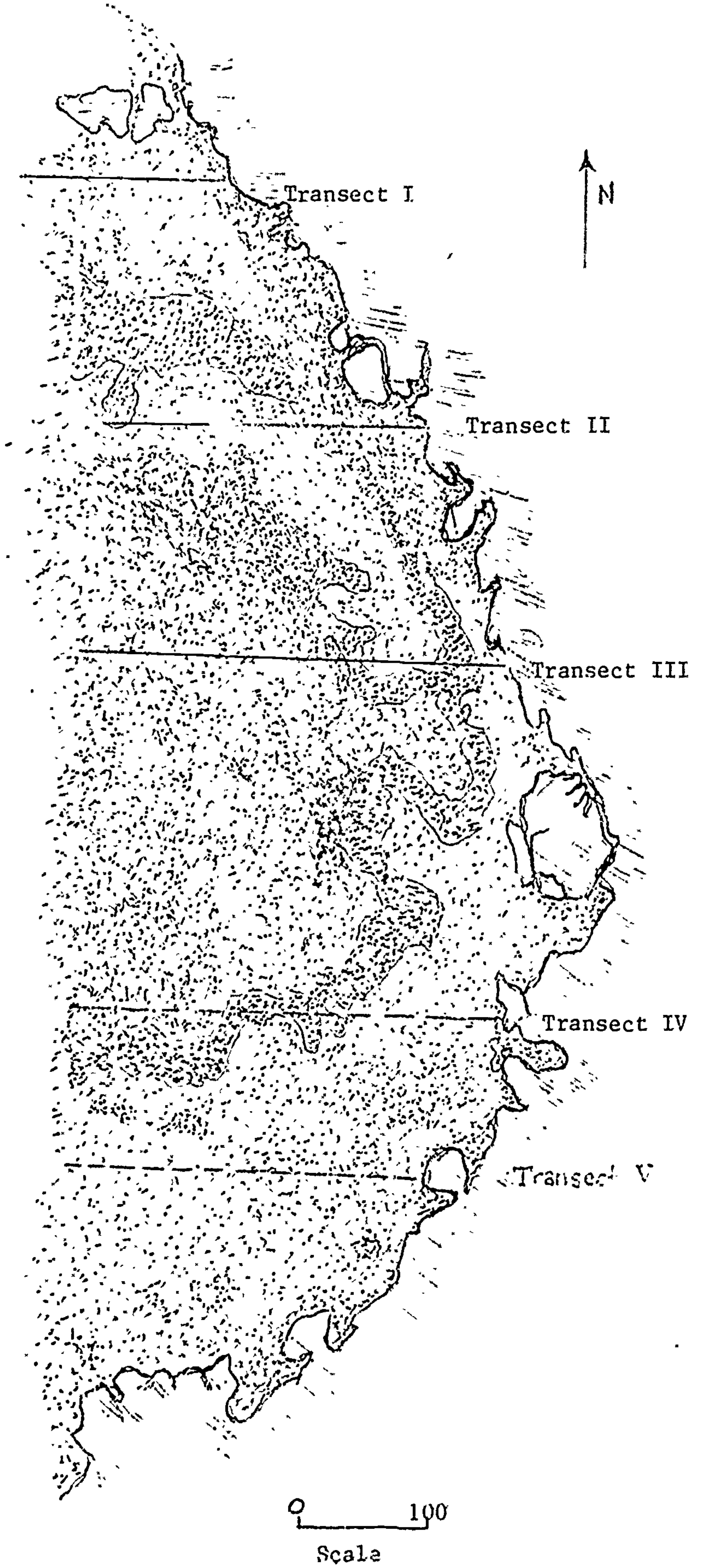


Figure 2. Representation of the aerial photograph taken by the National Oceanic and Atmospheric Administration. Actual photo available from:

Photogrammetry Branch N/CG2313
Nautical Charting Division
National Ocean Service, NOAA

Request: Lameshur Bay, St. John USVI

UAGII 3043 152.74 #2258. (cost $15)

The Qualitative Study: Transect Lines

In order to clarify the contents of the aerial photographs and to obtain an accurate bottom profile of the research site, a qualitative study was required. "In qualitative transect studies the aim is to record the variation of organisms and elevation along a transect in terms of taxa present and relative abundance without necessarily counting of measuring (Stoddart, 1972)."

Two sixty-five meter long nylon lines divided into half-meter segments were used in the qualitative study of the Tektite reef. Each one of the five transects (see figure 2) was approximately one hundred and ninety-five meters in length. This required the extra team to move the lines out after each sixty-five meters. Transect 1 was laid twice (90m), transects 2 through 4 were laid three times (120-165m) and transect 5 was laid four times (200m) - transects were discontinued once the line entered the algae flats. The transect lines started on the shore line at mean low tide water level and were laid down with the use of a compass (see figure 2 for headings) to a depth of sixty feet. Sixty feet was the maximum depth for reasons of safety and limited bottom time since all teams were working on a repetitive dive basis and excess nitrogen accumulation is always a threat with repetitive dives. Each dive team carried two 38 x 18 cm slates to record data underwater. Slate 1 had the species list (see Appendix A) with the scientific names of the 28 common coral species and substrate forms for these waters. Slate 2 was for general observations. As the team went down the transect line, one diver wrote down any peculiarities about the dive on Slate 2 and observed the first diver as a safety precaution as well as recording depth in feet every meter. Thus the qualitative study comprised recording of the coral species and substrate under the transect line.

The Quantitative Study: Measurements of Sample Parameters

"Quantitative studies consist of either (a) some form of continuous recording on transects or (b) sampling along transects. Continuous recording of parameters such as number of species, area covered, depth, etc. has been carried out by Manton (Stoddart, 1972)." Type (b) was the best method to follow for the quantitative part of the study. It would give a better idea of what the coral distribution and growth were like on the Tektite reef and provide zonation patterns of the site. As Manton had done previously in his quantitative study of the Low Isles and the Great Barrier Reef (Stoddart, 1972), ours also consisted of recording the parameters of samples down the transect line. Besides its use as the recording device of the qualitative part of the study, Slate 1 carried a one-meter nylon line divided into five 5cm segments attached to it. Length, width, and height of each coral colony under the transect line were measured with this line. This rustic but handy device proved to be an effective tool in a place where common rigid rulers proved useless because of their buoyancy, size, and inflexibility. The transect lines also proved to be an effective quantitative tool in open areas such as algae flats and sand bars where measuring with the one meter line consumed too much of our limited underwater time.

After every dive the teams transcribed all the data recorded into a log book which is included later in this paper (see Appendix C). Transformation of the data included a species distribution table to determine zonation patterns (Table 1), abundance histograms of the five most common species (figure 4), and a depth profile distribution graph of the five most common species (figure 5).

Results

Aerial photos provide a basis for locating areas suitable for ground truthing and transect work. A detailed rendition was produced from the photograph of the southern side of St. John (NOAA) (figure 2) which suggested patterns of substrate formation on which to base transect lines. Although a more detailed blow-up from the current photo of the Tektite site would be necessary to make fine distinctions of the coloration patterns and to compare them with our results, it is clear that the major coral formations and substrates that were found appear as distinct bands on the photograph.

Table 1. Species distribution relative to transect length.

Distance (m)		25	50	75	100	125	150
* *Acropora cervicornis*							
Transect 1			*	*			
Transect 3	**						
* *Agaricia agaricites*							
Transect 1		* ** **	** * * ** * *				
Transect 2			* ** *				
Transect 4	*		* *	*			
Transect 5	*	*					
Algae flats							
Transect 1				** ** ---→			
Transect 2					** ** ----		
Transect 3					* * * *	** ** ----	
Transect 4							
Transect 5	(Starts off of this chart.)						
Coral rubble							
Transect 1	* *** ** *	*	** *				
Transect 2				* **			
Transect 3	* *		*	*			
Transect 4		**	** *			*	
Transect 5		* *					
Dead coral							
Transect 1		** *** *** *	** ** ** **	** **			
Transect 2		** **	* **	* * **	* **		

Table 1. (continued)

Distance (m)	25	50	75	100	125	150
Dead Coral (con't)						
Transect 3		* *	* * * *	*	*	
Transect 4	* * **	* **	* * ** ***	** *	* ****	
Transect 5			**		*	
* Diploria clivosa						
Transect 4	*	*	*	*	**	
* Diploria labyrinthiformis						
Transect 1	*		**			
Transect 3	*				* *	
Transect 5		* *				
* Diploria strigosa						
Transect 1				* *		
Transect 2	*	*		*		
* Gorgonia species						
Transect 4	*	*			*	
Transect 5	*			*	*	
Millepora alcicornis						
Transect 1	** ** **	*** ** ******* *	**	*		
Transect 2	** *	** *** *				
Transect 3	** ***					
Transect 4	* ** ** *	*				
Transect 5	** ** * *					
Montastrea annularis						
Transect 1	*	** ***	*** * ** ****	**		
Transect 2		** ** **	* * *** *	* *** ** *	*	
Transect 3	* ***** *	* ** *	* ** * ***	* **** ** *	**	

Table 1. (continued)

Distance (m)	0–25	25–50	50–75	75–100	100–125	125–150
Montastrea annularis (con't)						
Transect 4	*	** **** *** *********	***** **** *** ******	* *** *******	* ** ****	
Transect 5	* *	* * * *****	******* *** * ********	******** **	** * ** **** ***	
* Muriceopsis flavida						
Transect 2				* * *		
Plexaura flexuosa						
Transect 1	*	* * * *	* *			
Transect 2		* *	** * **	* *		
Transect 3	*		**	*		
Transect 4		*	*		* *	
Transect 5		*	* * *	*		
Porites asteroides						
Transect 1	*	** *	*			
Transect 2	* *	*	* *	*		
Transect 3	* *					
Transect 4	** *				*	
Transect 5	*				*	
* Porites porites						
Transect 1		*	* ** ** * *	* **		
Transect 2		*	* ***	* * *		
Transect 4		*			* *	
Transect 5				*	*	
* Psuedopterogoroia bipinnata						
Transect 3				*	*	*
Transect 4				*	* *	*

Table 1. (continued)

Distance (m)	25	50	75	100	125	150
Rock rubble						
Transect 1	* *** ** ** ** ** *** * *** * ** *** *	* ** * ** *	* **			
Transect 2	* * ** ** * * * *	** ** * *	*	**		
Transect 3	* ** ** ** ** * ***					
Transect 4	** ** ** *	*	*			
Transect 5--	** ** ** * ** * ** * * * *	** ** *				
Sand						
Transect 1		* * ** ** ** * * *				
Transect 2	*	* ******** * * ******	* ** ** *	** ** ** *		
Transect 3	* * * *	* ** ** ** ** ** ** * * * *		** * *	*	
Transect 4	* ** * ** ** ** ***** ** * ** ***** *	** ** ** ** *** ** **	**** * * *	**** *		
Transect 5	* * * * ** ** ** ** ** ** ** ** **	** ** ** ** ** ** * ** **	*** * * * * ** ** **	** ** *		
*** Siderastrea species**						
Transect 1	** * * *	* ** * ** *				
Transect 2	* *					
Transect 3	*	*				

* If a species did not appear in a significant number (2) along a particular transect, it was omitted from the table for that transect.

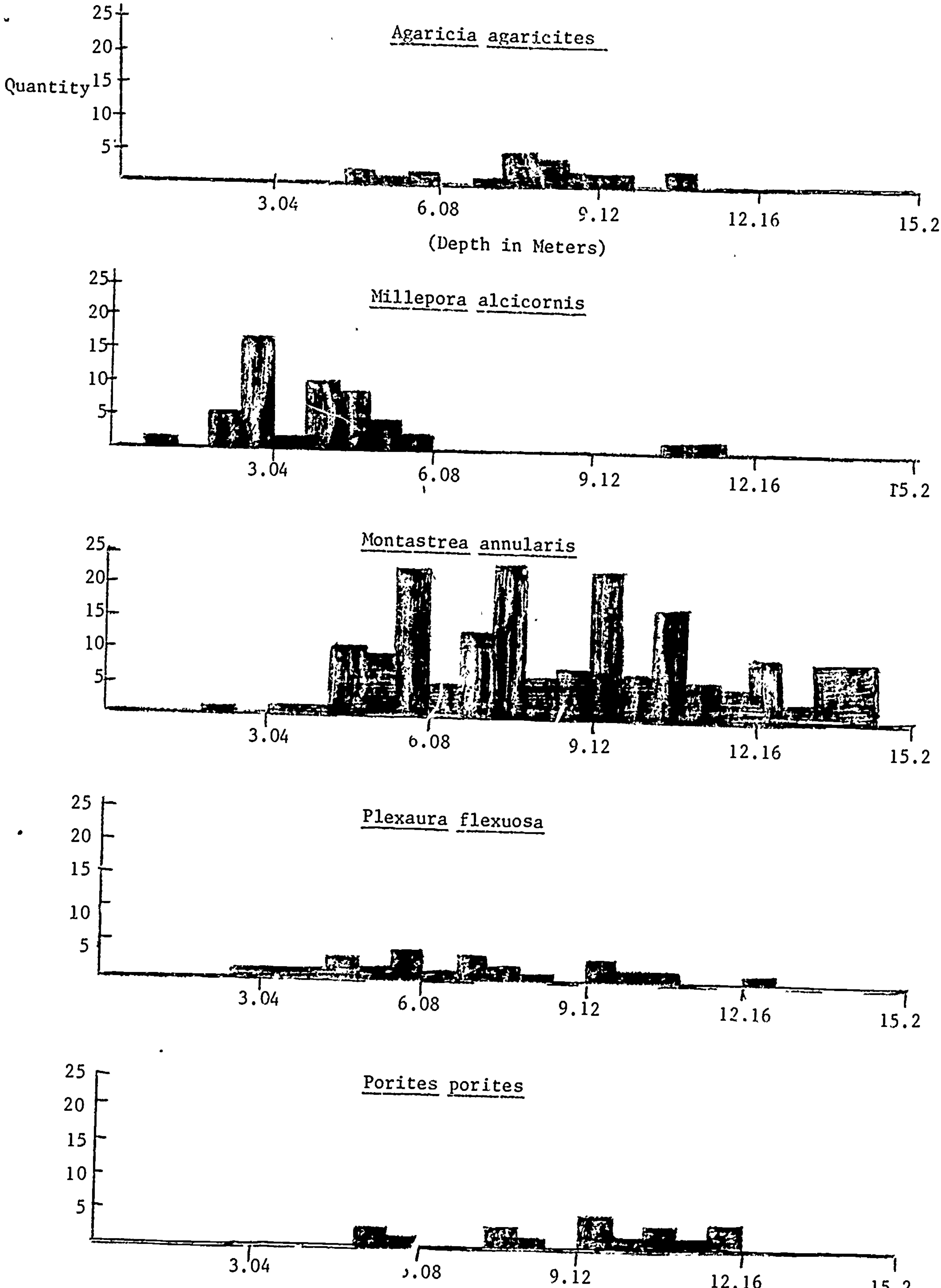


Figure 4. Abundance of the five most common coral species relative to depth.

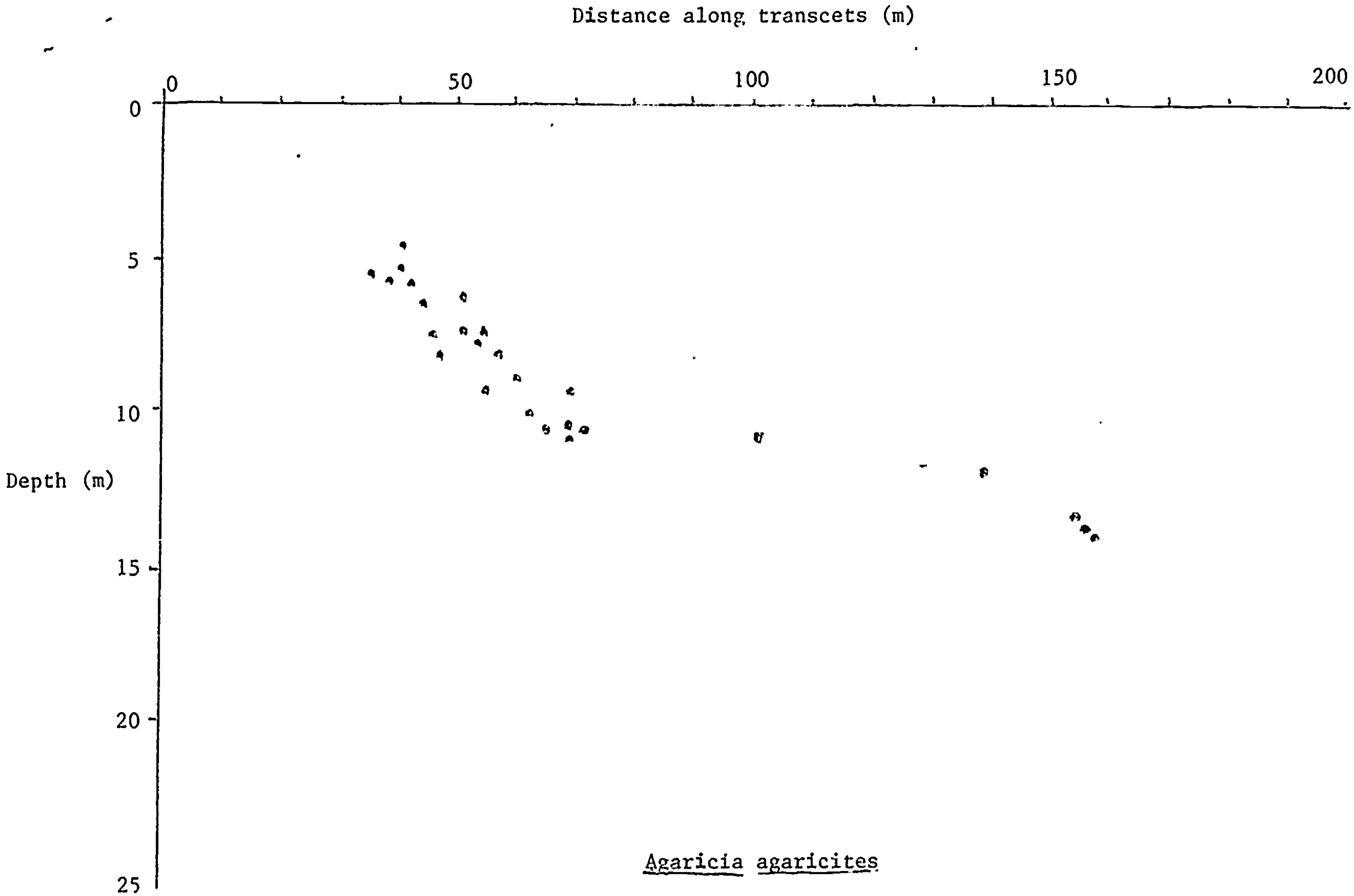


Figure 5(a). Depth profile distribution of the five most common coral species.

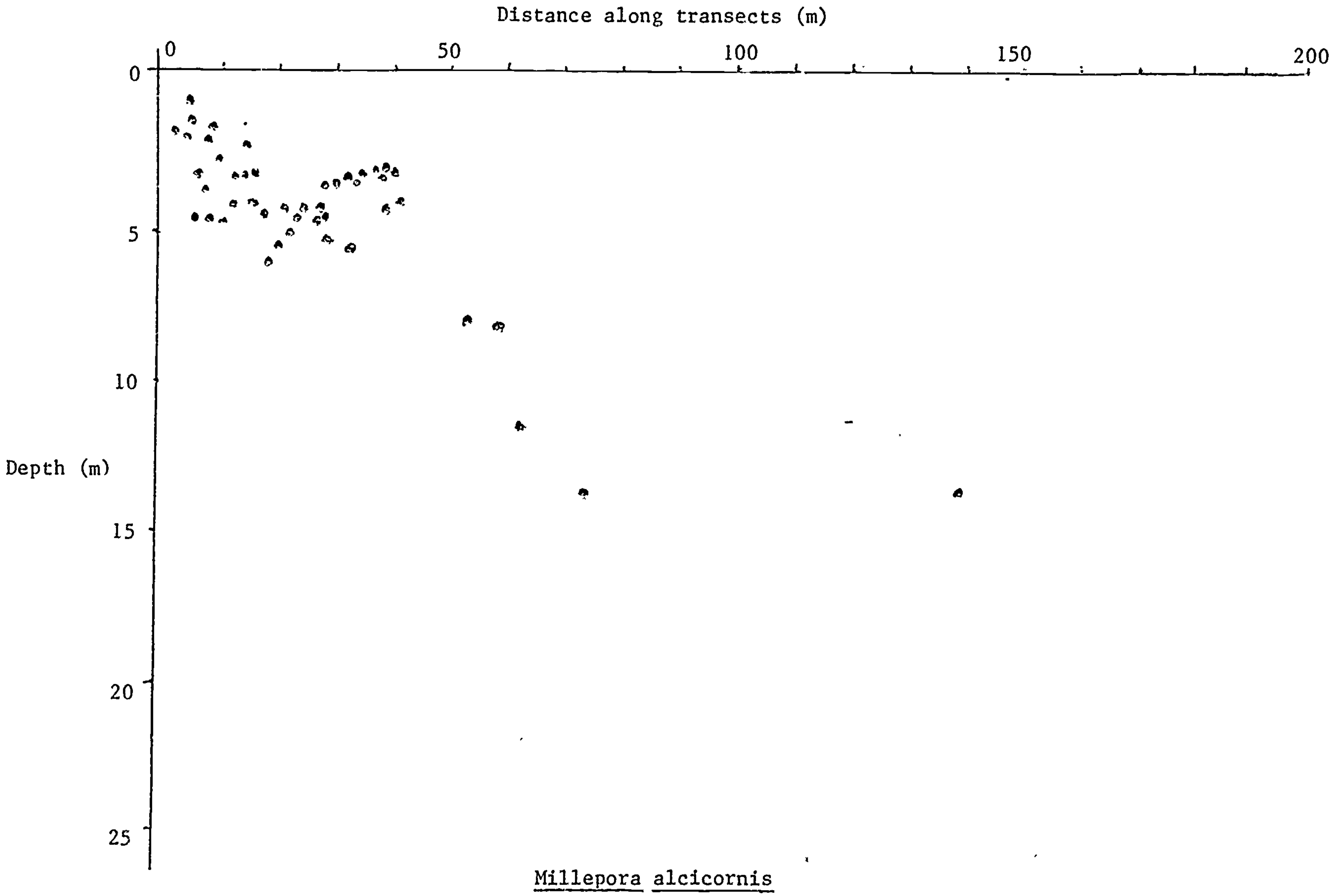
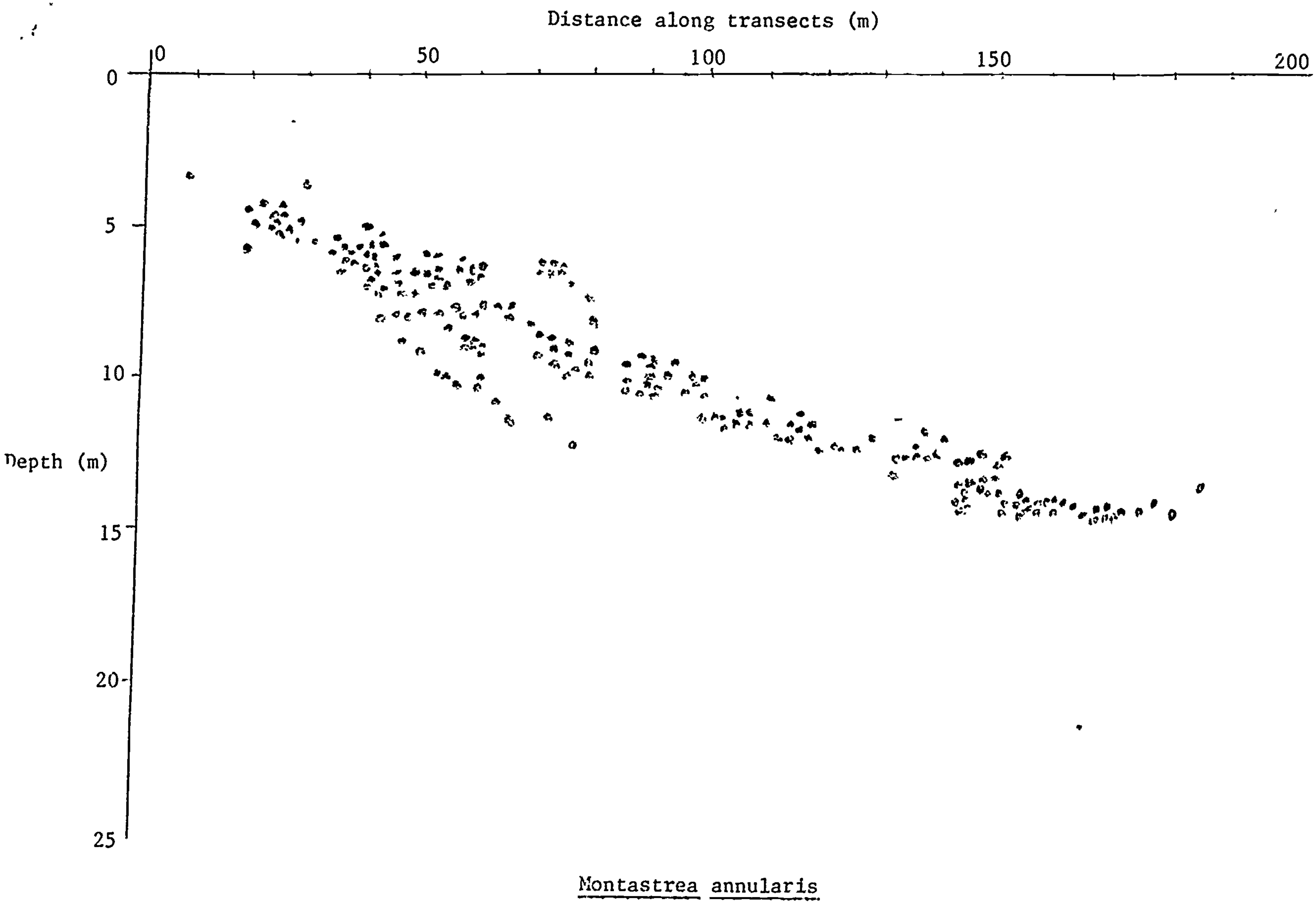
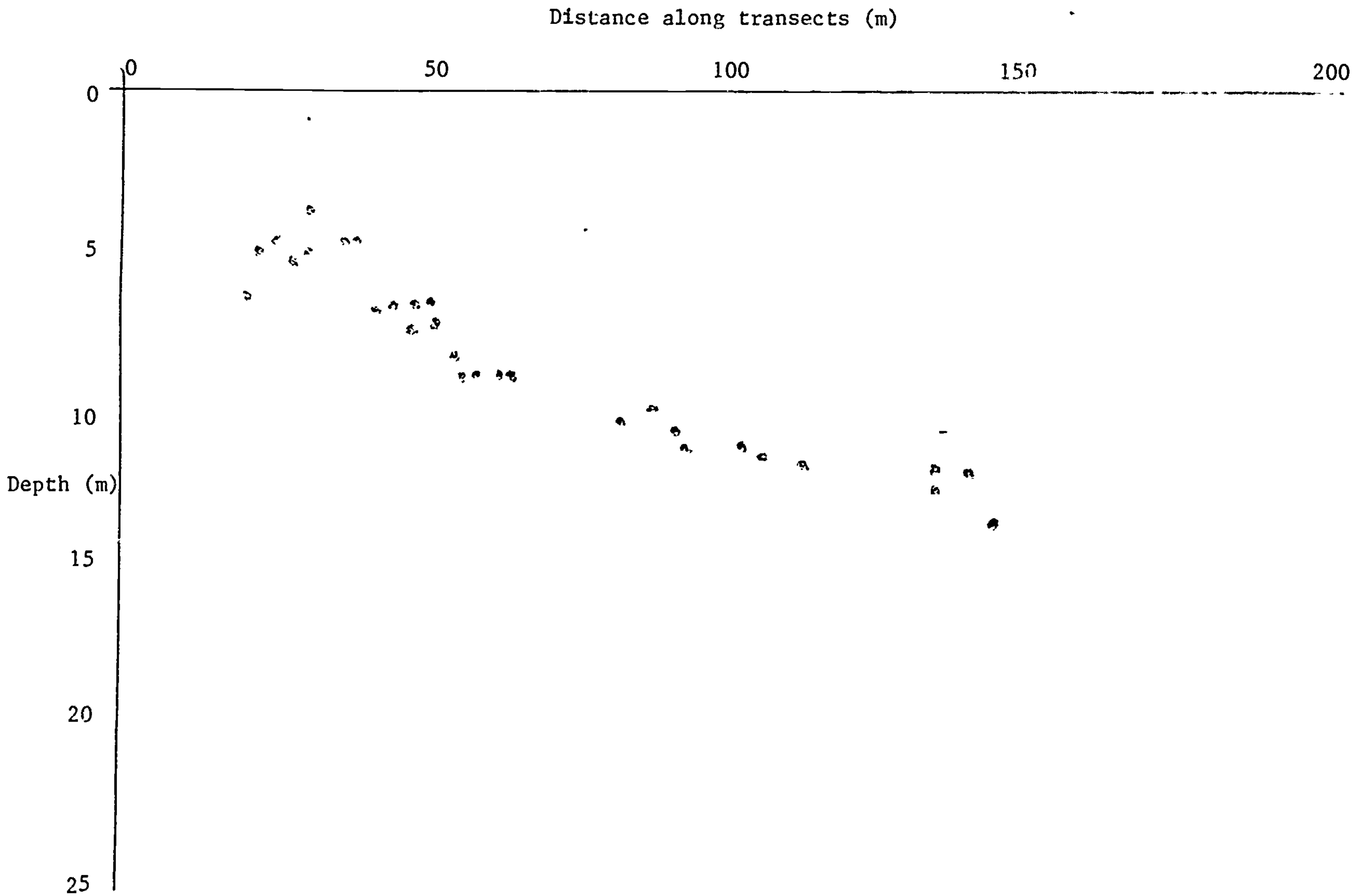


Figure 5(b). Depth profile distribution of the five most common coral species.



Firgure 5(c). Depth profile distribution of the five most common coral species.



Plexaura flexuosa

Figure 5(d). Depth profile distribution of the five most common coral species.

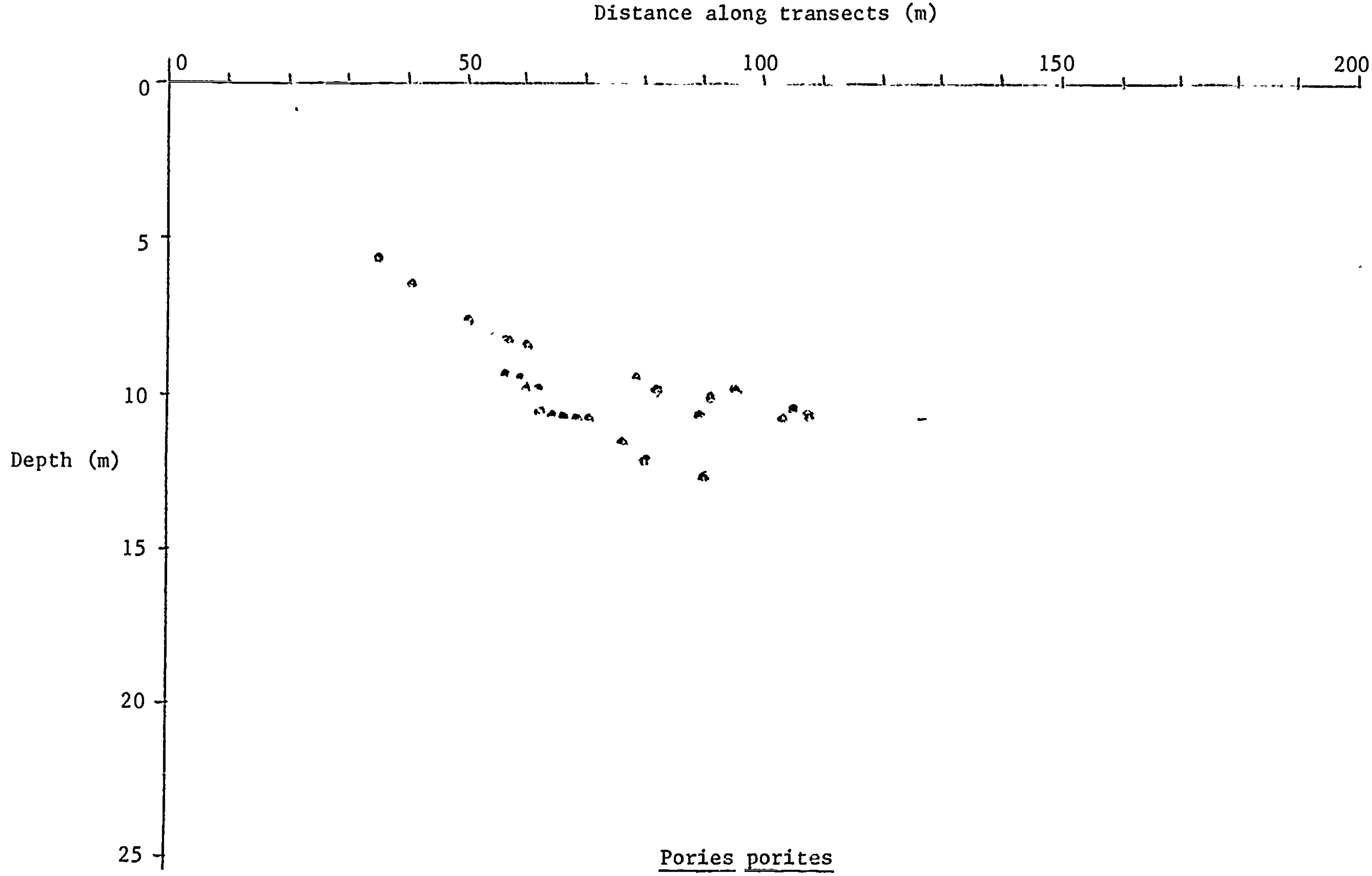


Figure 5(e). Depth profile distribution of the five most common coral species.

Out of the twenty-eight species and substrate forms studied, five species dominated the reef (Table 1). The most abundant by far was Montastrea annularis, followed by Millipora alcicornis. Plexaura flexuosa, Agaricia agracites, and Porites porites each were seen in approximately equal abundance (figure 4). Definite zonation patterns also appeared. Millipora alcicornis appeared first to a depth of seven meters and from shore to fifty meters out. Montastrea annularis ranged from five to eighteen meters in depth, starting at twenty meters out from shore and continuine to the algae flats. Agaricia agracites, Porites porites, and Plexaura flexuosa each appeared at three to fourteen meters in depth and from twenty-five to eighty meters, fifty to one hundred twenty-five meters, and fifteen to sixty meters out from shore respectively (figure 5).

Conclusions

The results from this project are valid for the purposes of the MAB project. They are, in fact, more detailed than further studies on the island will be. Five transects provided more than enough information for the objectives of MAB; however, if more specific information on particular species were desired, more transects, hopefully no less than nine, would be required (Stoddart, 1972). Even though personal variations in observations , species identification, and measurements undoubtedly existed. the time spent underwater and the quantity of data collected lessened the significance of this. This methodology is suitable and appropriate for any team of easily trained technicians for work in other marine environments. It is also inexpensive and requires a relatively small amount of time for training and implementation of the project. Careful monitoring of all activities involving SCUBA skills with the appropriate equipment must be regarded at all times. Also, qualified maintenance of all equipment must be available, especially in remote areas, to insure quick and efficient completion of the work.

Recommendations

Two other possibilities for measurement and study exist. On the more general level, dimensions of broad zones, e.g. algae flats, sand, coral, grass beds, etc., could be measured (Kumpf and Randall, 1961). More precise studies could be made using quadrats and underwater photographs along transect lines. School for Field Studies and similiar research groups should in future studies continue monitoring the Tektite area to determine changes in the system. Also, studies should be made in the Reef Bay area, where recent development could be damaging nearby marine environments due to run off and sedimentation. It is important to maintain open lines of communication between research teams and concerned scientists to facilitate studies and make available additional relevant information and provide adequate logistical support.

This project has demonstrated the feasibility of the collaboration between a federal organization, field research stations, and motivated educational groups to produce knowledge about fragile ecosystems. It is our hope that the results of this project will contribute to future policy and management of coral reefs.

Appendix A

UNDERWATER DATA COLLECTION SLATE

Transect # ____

Slate # ____

Names

1) __________

2) __________

Date__________

Time in ________ Time Out ________

Residual Nitrogen

Time ______

______

1. Mont. annularis
2. Mont. cavernosa
3. Por. astreoides
4. Por. porites
5. Dipl. labyrin.
6. Dipl. strigosa.
7. Dipl. clivosa.
8. Agar. agaricites.
9. Agar. lamarcki.
10. Sider. siderea.
11. Meandr. meandr .
12. Acropo. palmata.
13. Acropo. cervicornis.
14. Dendro. cylindrus.
15. Mill. alcicornis.
16. Mussa angulosa.
17. Favia. fragum .
18. Gorgonia.
19. Briar . asbest.
20. Plex. flex.
21. Pseudop . bipinn.
22. Eunicea mammo .
23. Sand
24. Rock Rubble
25. Coral Rubble
26. Grass beds
27. Algae Flats
28. Dead Coral

genus/species	length cm	width cm	height cm	depth m	NOTES

Appendix B

SPECIES LIST

SUBKINGDOM Metazoa

PHYLUM Cnidaria (Coelenterata)

CLASS Hydrozoa

ORDER Hydrocorallina

FAMILY Milleporidae

Millepora alcicornis

CLASS Anthozoa

SUBCLASS Hixacorallia (Zoantharia)

ORDER Scleractinia

SUBORDER Astrocoeniida

FAMILY Acroporidae

Acropora cervicornis

Acropora palmata

SUBORDER Fungiida

FAMILY Agariciidae

Agaricia agaricites

Agaricia lamarcki

FAMILY Siderastreidae

Siderastrea spp.

FAMILY Poritidae

Porites asteroides

Porites furcata

Porites porites

SUBORDER Faviida

FAMILY Faviidae

Favia fragum

Diploria clivosa

Diploria labyrinthiformis

Diploria strigosa

Manicina mayori

Montastrea annularis

Montastrea cavernosa

Appendix B (con't)

FAMILY Trochosmiliidae

Meandrina meandrites

Dichocoenia stokesii

Dendrogyra cylindrus

FAMILY Mussidae

Mussa angulosa

Mycetophyllia lamarckiana

Isophyllia sinuosa

SUBORDER Caryophyllida

FAMILY Caryophyllidae

Eusmilia fastigiata

SUBCLASS Octocorallia (Alcyonaria)

ORDER Gorgonacea

Briareum asbestinum

Plexaura flexuosa

Pseudopterogorgia bipinnata

Eunicea mammosa

Muriceopsis flavida

Gorgonia spp.

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